Energy Conservation Standards for Distribution Transformers

Webcast Presentation

Building Technologies Program
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

August 10, 2004

Purpose

Prepare Stakeholders for Providing Input at the Public Meeting

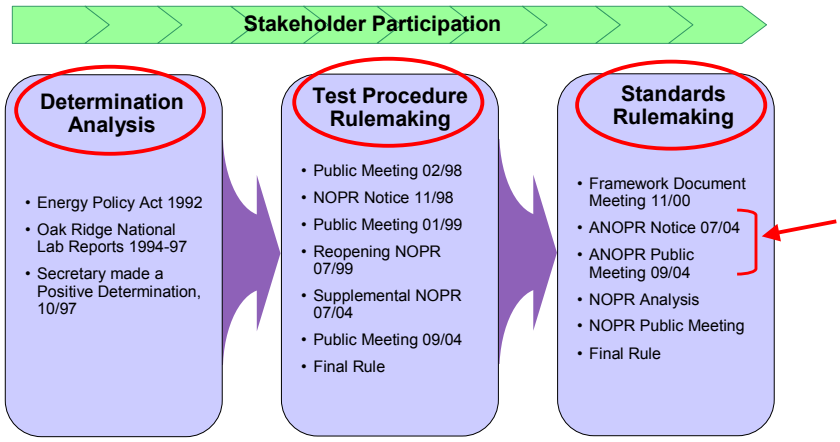
- The Department wants to assist stakeholders in understanding and interpreting the material developed for the ANOPR
- Advance Notice of Proposed Rulemaking (ANOPR)
  Federal Register notice published July 29, 2004
- Focus on the spreadsheet tools developed for the ANOPR
- Explain how to use and apply the spreadsheet tools before the public meeting

Educational & Familiarization Purposes

- Familiarize stakeholders with ANOPR spreadsheet tools
- Opportunity to ask clarification questions at the end of each section discussed today relating to the material presented
- The webcast is not part of the formal process and has no provision for capturing comments for the record
- This is not a forum to critique the ANOPR analysis
- The Department requests comments at the public meeting or in writing

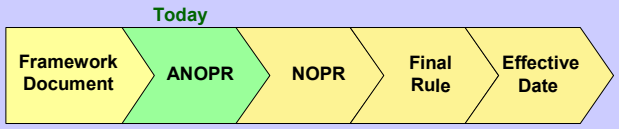
1. Rulemaking Overview
2. Product Classes
3. Engineering Analysis
4. Life-Cycle Cost and Payback Periods
5. National Impact Analysis

Principal Procedural Steps for Distribution Transformers



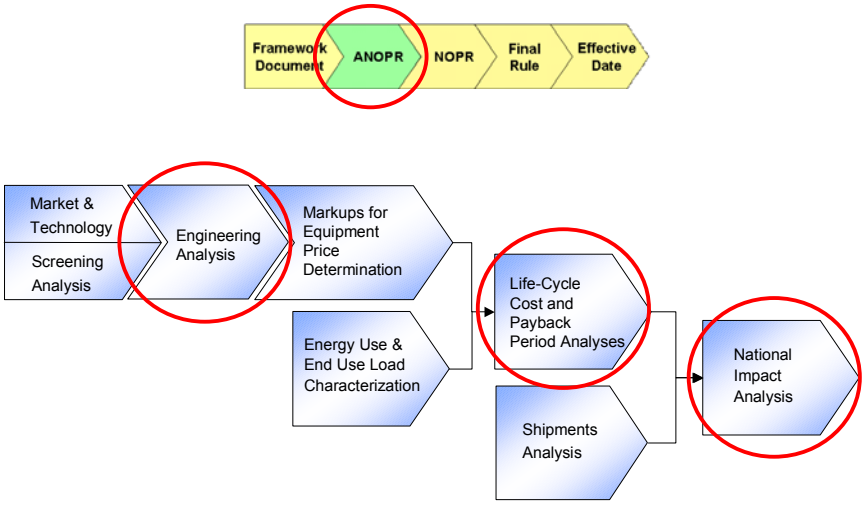
Stages of the Rulemaking Process

Standards Rulemaking



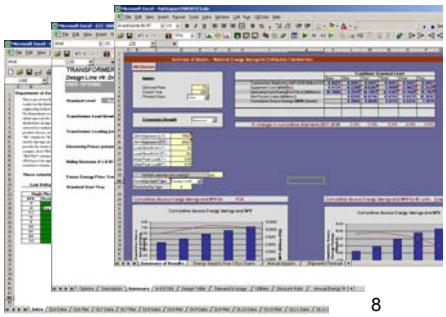
- ✓ Federal Register Notices
- ✓ Written Comments
- ✓ Meetings and Oral Comments
- ✓ Web-posting Draft Analysis
- ✓ Consultative Meetings
- ✓ Webcasts

ANOPR Analyses Flow Diagram



ANOPR Documents and Material Published

- **Federal Register Notice**
- **Technical Support Document (ANOPR version)**
- **Engineering Analysis (2 spreadsheets)**
- **Life-Cycle Cost and Payback Period (13 spreadsheets)**
- **National Impact Analysis (1 spreadsheet)**



ANOPR Documents and Material Published

- **Webcast today to focus on explaining the spreadsheets posted on the web**
- **ANOPR public meeting 09/28/04**
- **ANOPR - submit comments by 11/09/04**
- **Please reserve your comments on the analysis for either the public meeting or submit written comments for the record**
- **Federal Register Notice, Technical Support Document and Spreadsheets published on the DOE website**
- **http://www.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers.html**

How to Submit Comments…

- Public Meeting – oral comments will be captured in the transcript and become part of the public record.
- Written comments – comment period open until 11/09/04
  Reference docket #: EE-RM/STD-00-550 and/or RIN #: 1904-AB08

Email: TransformerANOPRComment@ee.doe.gov

Mail: Ms. Brenda Edwards-Jones
U.S. Department of Energy
Building Technologies Program, Mail stop EE-2J
1000 Independence Avenue, SW
Washington DC, 20585-0121

Courier: Ms. Brenda Edwards-Jones
U.S. Department of Energy
Building Technologies Program, 1J-018
1000 Independence Avenue, SW
Washington DC, 20585-0121
Tel: 202 586 2945

Agenda

1. Rulemaking Overview
2. **Product Classes**
3. Engineering Analysis
4. Life-Cycle Cost and Payback Periods
5. National Impact Analysis

Transformer Characteristics

Definition of a Distribution Transformer

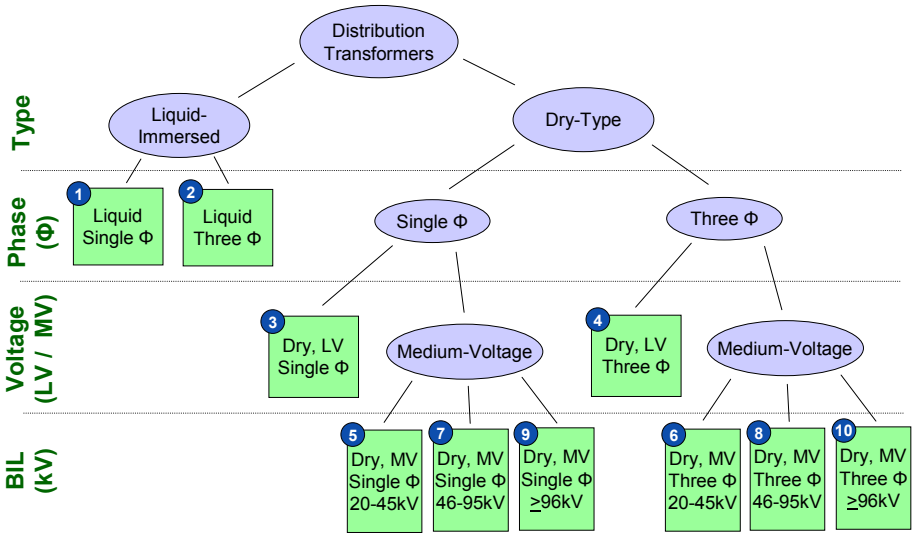
Distribution transformer means a transformer with a primary voltage of equal to or less than 35 kV, a secondary voltage equal to or less than 600 V, a frequency of 55-65 Hz, and a capacity of 10 kVA to 2500 kVA for liquid-immersed units and 15 kVA to 2500 kVA for dry-type units, and does not include the following types of transformers:

(1) autotransformer;
(2) drive (isolation) transformer;
(3) grounding transformer;
(4) harmonic mitigating transformer;
(5) K-factor transformer;
(6) machine-tool (control) transformer;
(7) non-ventilated transformer;
(8) rectifier transformer;
(9) regulating transformer;
(10) sealed transformer;
(11) special-impedance transformer;
(12) testing transformer;
(13) transformer with tap range greater than 15%;
(14) uninterruptible power supply transformer; or
(15) welding transformer.

Product Class Characteristics

Type	Liquid-immersed or Dry-type
Phase	Single or Three-phase
Voltage	Low or Medium Voltage (Dry-type only)
BIL	Basic Impulse Insulation Level (Dry-type MV only)

The Department's Ten Product Classes



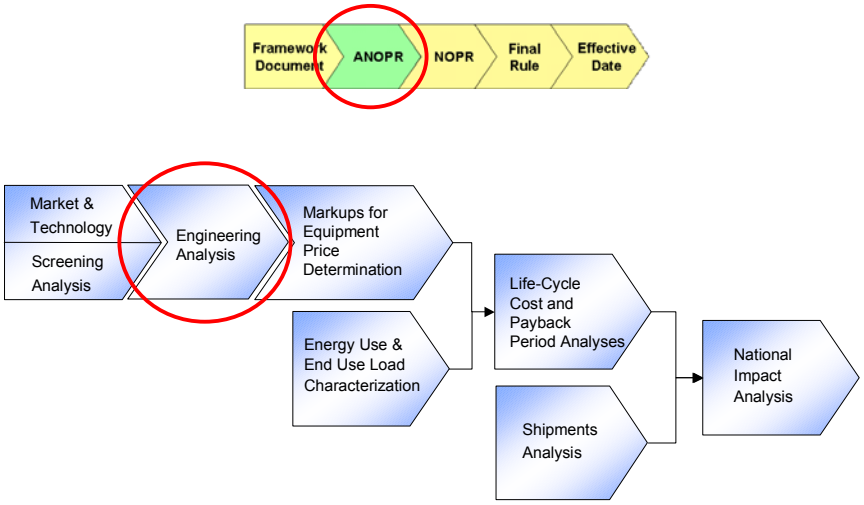
Ten Product Classes and kVA Ranges

- Product classes table and number of kVA ratings in each

PC	Type	Phase	Voltage	BIL	kVA	Ratings
1	Liquid	Single	-	-	10-833	13
2	Liquid	Three	-	-	15-2500	14
3	Dry	Single	Low	-	15-333	9
4	Dry	Three	Low	-	15-1000	11
5	Dry	Single	Medium	20-45 kV	15-833	12
6	Dry	Three	Medium	20-45 kV	15-2500	14
7	Dry	Single	Medium	46-95 kV	15-833	12
8	Dry	Three	Medium	46-95 kV	15-2500	14
9	Dry	Single	Medium	>96 kV	75-833	8
10	Dry	Three	Medium	>96 kV	225-2500	8

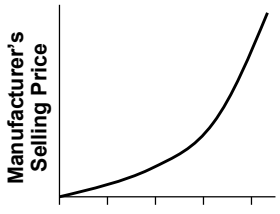
- In total there are 115 kVA ratings across the ten product classes

ANOPR Analyses Flow Diagram



Price-Efficiency Curves

Price - Efficiency Relationship



Rulemaking Analyses

- **Life-Cycle Cost** *(ANOPR Analysis)*
- **Manufacturer Impact** *(NOPR Analysis)*
- **Employment Impact** *(NOPR Analysis)*

Early Consultation and Refinement

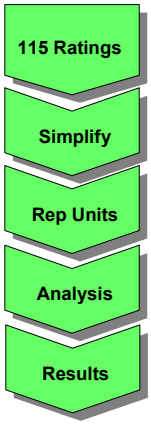
- Framework Document comments were reviewed and considered.
- Draft Engineering Analysis posted in December 2001
- Met with nine manufacturers in early 2002
- Revised Engineering Analysis published June 2002
- Draft Dry-type Distribution Transformer Engineering Analysis in August 2002


Distribution Transformer Rulemaking

Engineering Analysis Update

(Draft for review only)

Engineering Analysis Process



- Start with 10 product classes and 115 discrete kVA ratings
- Create Engineering Design Lines – 13 sub-groupings of the product classes
- Select 13 representative units – one from each design line
- Select design option combinations and use OPS software to prepare cost-efficiency curves
- Provide price-efficiency relationship for use in the LCC

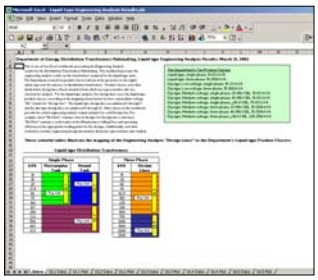
Engineering Analysis Results Spreadsheets, April 2003

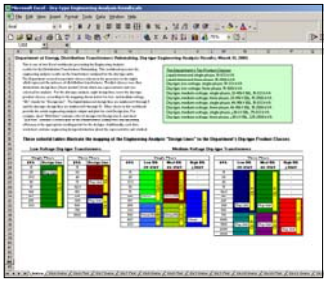
- **Liquid-immersed Distribution Transformers**

http://www.eere.energy.gov/buildings/appliance_standards/commercial/docs/liquid_type_engineering_results.xls

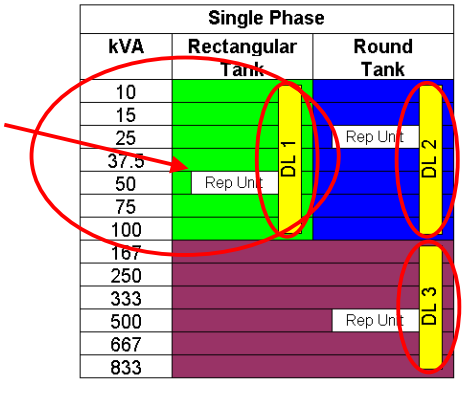
- **Dry-type Distribution Transformers**

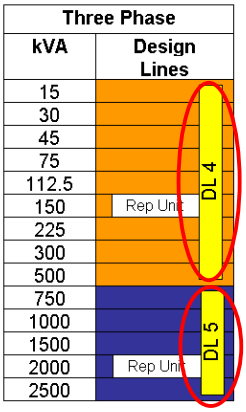
http://www.eere.energy.gov/buildings/appliance_standards/commercial/docs/dry_type_engineering_results.xls





Liquid-Immersed
Product Class to Design Line Mapping





Dry-Type Low-Voltage
Product Class to Design Line Mapping

Single Phase	
kVA	Design Line
15	DL 6
25	DL 6 (Rep Unit)
37.5	DL 6
50	DL 6
75	DL 6
100	DL 6
167	DL 6
250	DL 6
333	DL 6

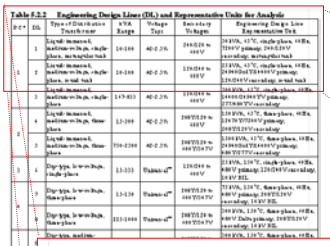
Three Phase	
kVA	Design Line
15	DL 7
30	DL 7
45	DL 7
75	DL 7 (Rep Unit)
112.5	DL 7
150	DL 7
225	DL 8
300	DL 8 (Rep Unit)
500	DL 8
750	DL 8
1000	DL 8

Dry-Type Medium-Voltage
Product Class to Design Line Mapping

Single Phase			
kVA	Low BIL 20-45kV	Med BIL 46-95kV	High BIL ≥96kV
15	DL9 / 3	DL11 / 3	-
25	DL9 / 3	DL11 / 3	-
37.5	DL9 / 3	DL11 / 3	-
50	DL9 / 3	DL11 / 3	-
75	DL9 / 3	DL11 / 3	DL13 / 3
100	Virtual RU	Virtual RU	DL13 / 3
167	DL9 / 3	DL11 / 3	DL13 / 3
250	DL10 / 3	DL12 / 3	DL13 / 3
333	DL10 / 3	DL12 / 3	DL13 / 3
500	Virtual RU	Virtual RU	DL13 / 3
667	DL10 / 3	DL12 / 3	Virtual RU
833	DL10 / 3	DL12 / 3	DL13 / 3

Three Phase			
kVA	Low BIL 20-45kV	Med BIL 46-95kV	High BIL ≥96kV
15	DL 9	DL 11	-
30	DL 9	DL 11	-
45	DL 9	DL 11	-
75	DL 9	DL 11	-
112.5	DL 9	DL 11	-
150	DL 9	DL 11	-
225	DL 9	DL 11	DL 13
300	DL 9 (Rep Unit)	DL 11 (Rep Unit)	DL 13
500	DL 9	DL 11	DL 13
750	DL 10	DL 12	DL 13
1000	DL 10	DL 12	DL 13
1500	DL 10 (Rep Unit)	DL 12 (Rep Unit)	DL 13
2000	DL 10	DL 12	DL 13 (Rep Unit)
2500	DL 10	DL 12	DL 13

Product Class to Design Line Mapping Summary Table

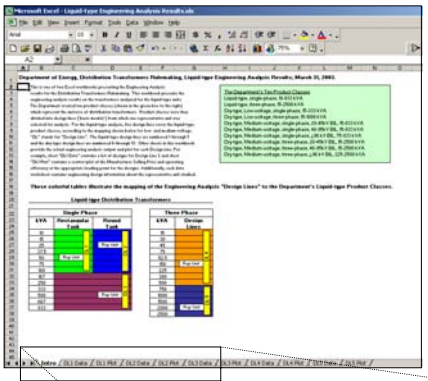


TSD Chapter 5
Table 5.2.2 on page 5-4

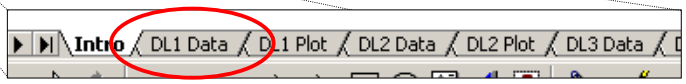
Table 5.2.2 Engineering Design Lines (DL) and Representative Units for Analysis

PC*	DL	Type of Distribution Transformer	kVA Range	Voltage Taps	Secondary Voltages	Engineering Design Line Representative Unit
1	1	Liquid-immersed, medium-voltage, single-phase, rectangular tank	10-100	±2-2.5%	240/120 to 600V	50kVA, 65°C, single-phase, 60Hz, 7200V primary, 240/120V secondary, rectangular tank
	2	Liquid-immersed, medium-voltage, single-phase, round tank	10-100	±2-2.5%	120/240 to 600V	25kVA, 65°C, single-phase, 60Hz, 24940GrdY/14400V primary, 120/240V secondary, round tank
		Liquid-immersed,				500kVA, 65°C, single-phase, 60Hz,

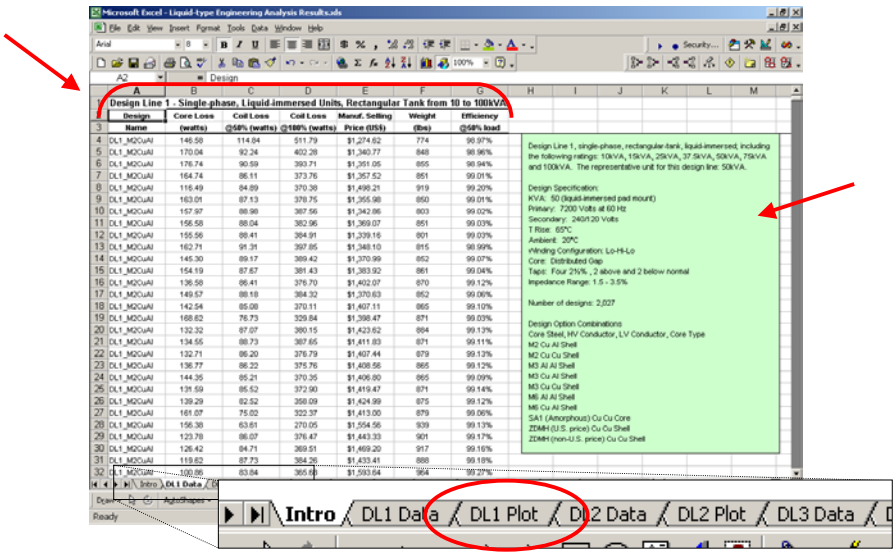
Liquid-Immersed Results Spreadsheet



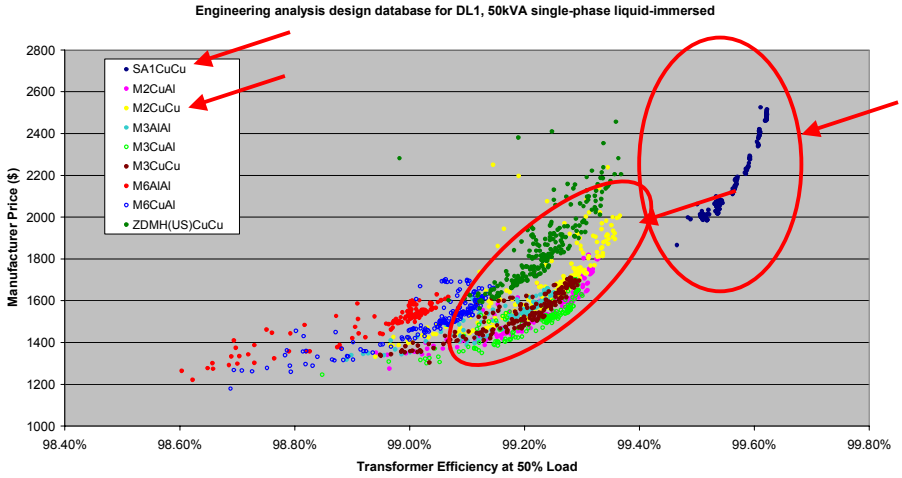
- Cover sheet is shown
- Click on tabs at bottom of page to review results for each of the Design Lines
- Separate spreadsheets for data and the cost/efficiency plots



DL1 Representative Unit Data Worksheet



DL1 Representative Unit Plot Worksheet



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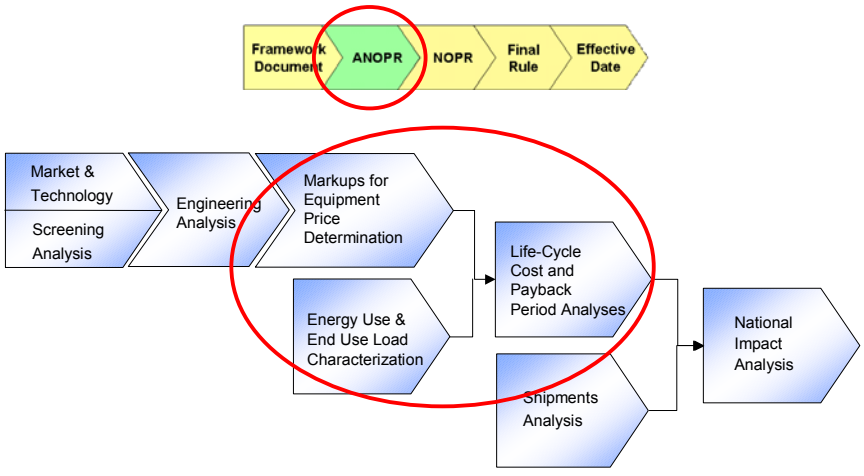
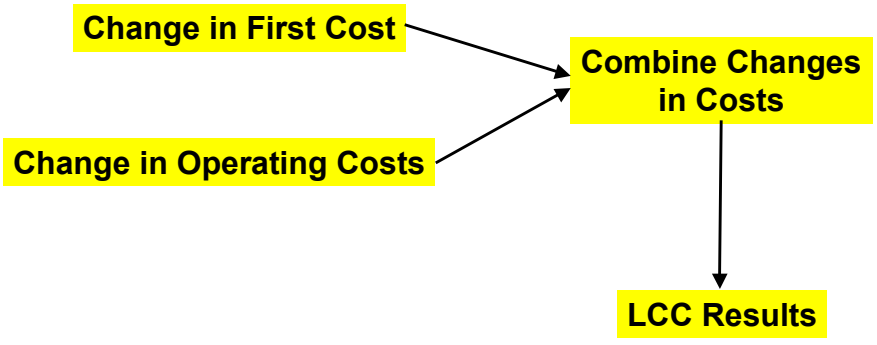
ANOPR Analyses Flow Diagram



Economic Evaluation from the Customer Perspective

- Change in installed cost
- Change in operating cost
- The relative importance of first cost and operating cost

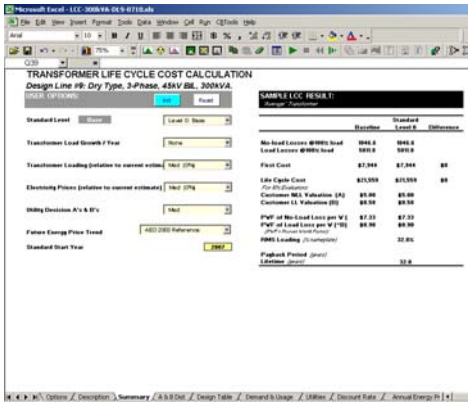


Basic LCC Process

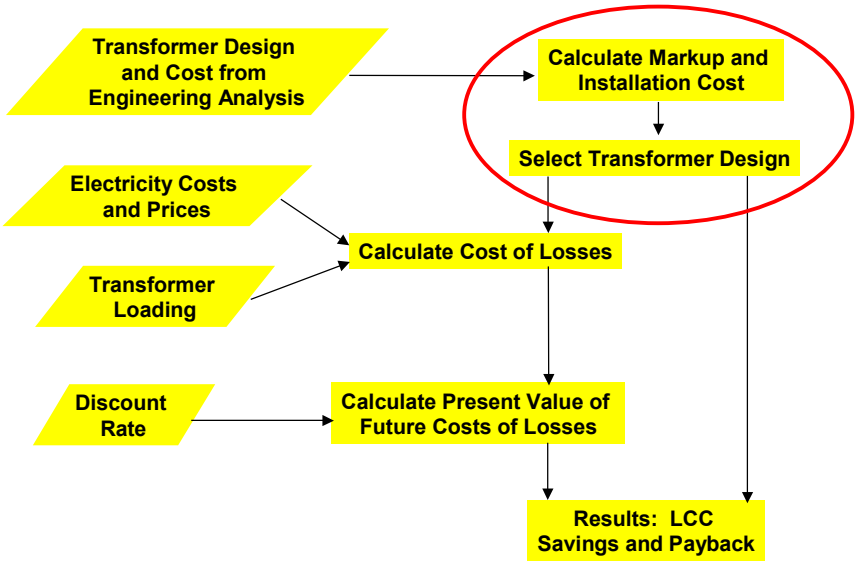
- LCC equals installed cost plus the sum of operating costs discounted to a particular base year
- Implemented in an Excel® spreadsheet
- Key sensitivities can be tested
- Results are expressed as LCC difference (baseline minus candidate standard)
- Separate LCC spreadsheet for each of 13 representative units for 13 design lines

Life-Cycle Cost and Payback Period (13 spreadsheets)

http://www.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers_spreadsheets.html

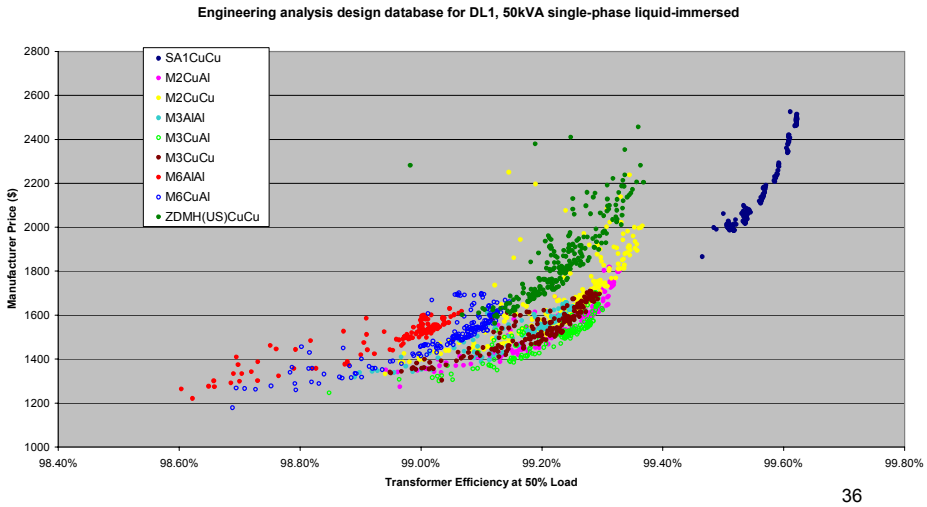


Simplified LCC Spreadsheet Flowchart



Engineering Analysis

Cost-Efficiency Relationship for Representative Unit from Design Line 1



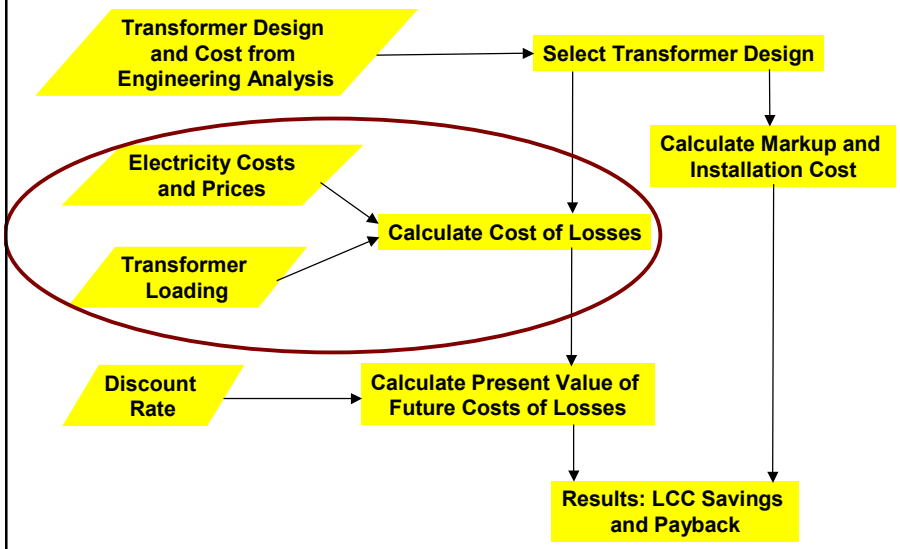
Example Markup and Installation Cost
Design Line 1, Liquid-Immersed, 50 kVA, Single-Phase

Manufacturer's selling price	$1,275
Shipping	$ 77
Sales tax	$ 151
Cost of installation	$1,441
Installed cost	$2,944

Example Markup and Installation Cost
Design Line 7, Dry-Type, 75kVA, Three-Phase, Low Voltage

Manufacturer's selling price	$ 963
Distributor markup	$ 337
Shipping	$ 109
Contractor markup	$ 141
Sales tax	$ 146
Cost of installation	$1,160
Installed cost	$2,855

Simplified LCC Spreadsheet Flowchart



LCC Analysis

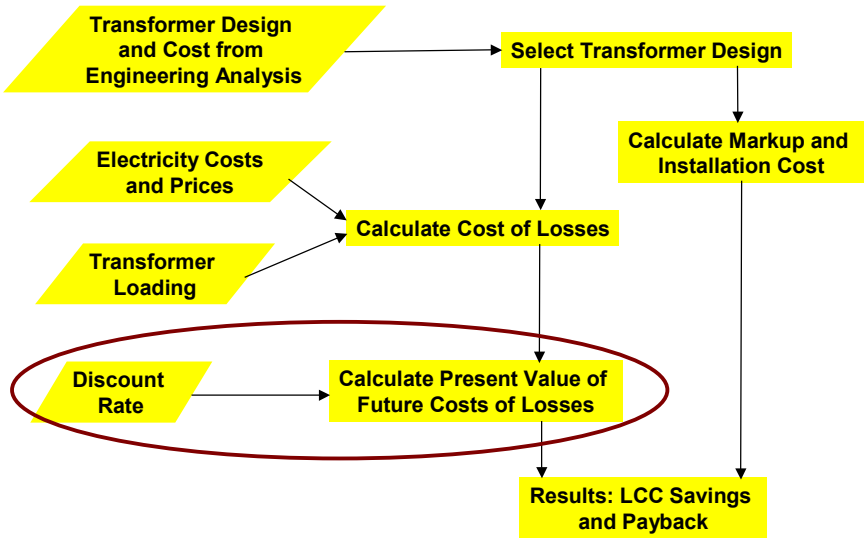
Electricity Cost

- Liquid-immersed distribution transformers
  - Hourly marginal electricity costs
  - Both capacity and energy components
  - FERC and electricity market data

- Dry-type distribution transformers
  - Monthly electricity bills
  - Both demand and energy charges
  - Tariff data from about 100 utilities

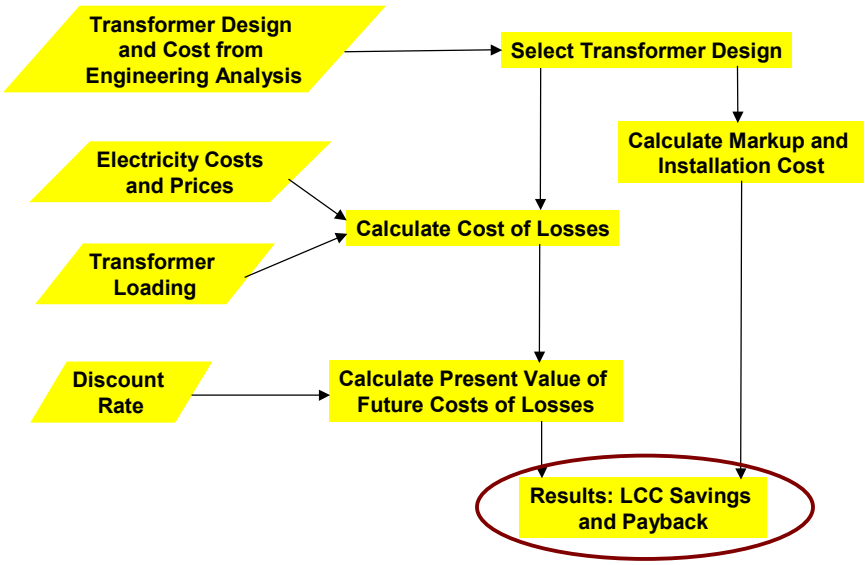
Transformer Loading

- Average transformer loading
  - < 100 kVA liquid-immersed ~ 30% RMS
  - > 100 kVA liquid-immersed ~ 50% RMS
  - Dry-type low and medium voltage ~ 35% RMS
- References
  - Technical Support Documents: technical details
  - IEEE Transformer Loss Evaluation Guide: background



Discount Rates

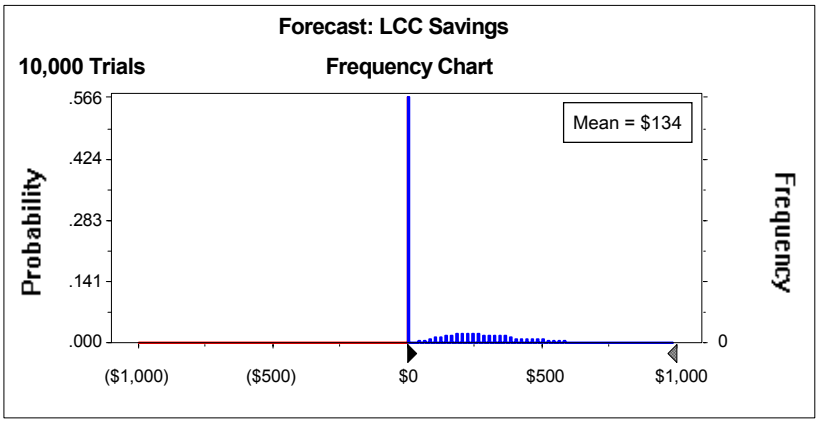
- Relative (time) value of money
  - Now versus later
- Determined by the interest rate for borrowed money and the rate of return on equity
- Interest rates are borrower-dependent
- DOE analysis determines discount rate by owner type
- Analysis, and consequently the discount rate, are in real terms



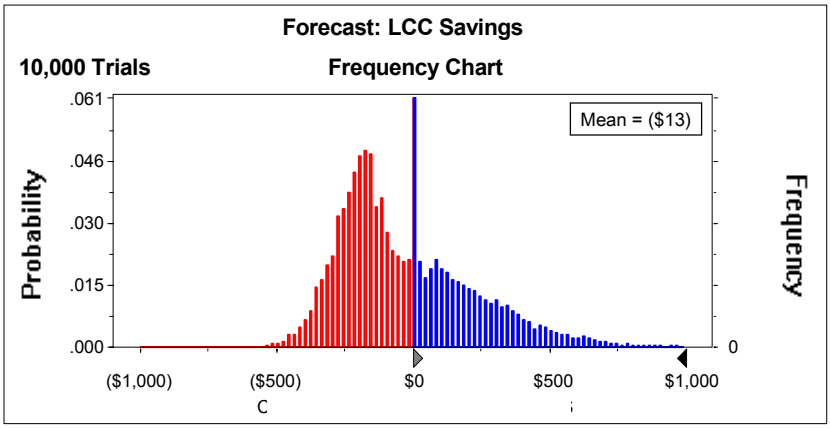
Customer Variation

- Every customer is unique
- We represent the variability among customers using distributions of various input variables
- Monte Carlo simulation is a statistical technique that samples from input variable distributions
- LCC results produced as 10,000-iterations
  - Implemented with Crystal Ball®, supplement to Excel

LCC Savings for CSL1, Design Line 1



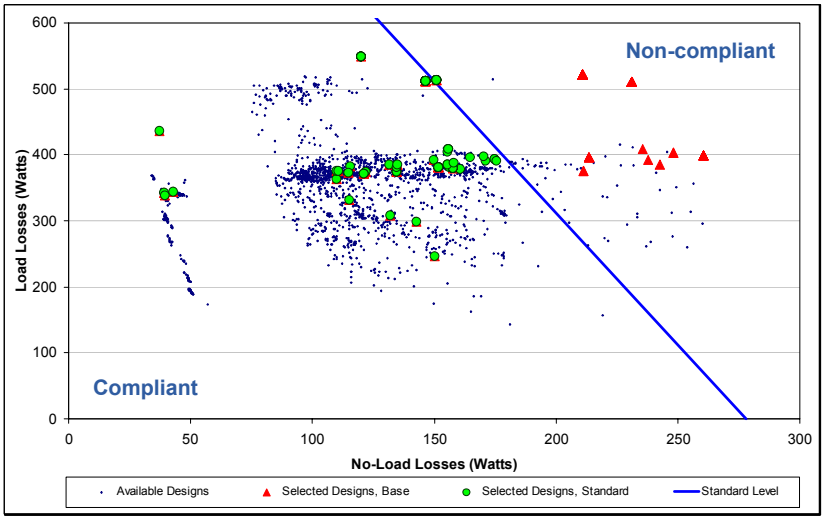
LCC Savings for CSL3, Design Line 1



Design Selection Using Parameters A and B

- Common industry descriptors, A and B, capture current market purchase decision criteria
  - A = equivalent first cost of no-load (core) losses
  - B = equivalent first cost of load (winding) losses
- Distributions of A and B represent variability
- Characterize current market conditions not subject to a mandatory efficiency standard
- Distinct evaluation percentages applied to liquid-immersed and dry-type

DL1 at 50% Load Example Design Selection



Summary Sheet from Spreadsheet

TRANSFORMER LIFE-CYCLE COST CALCULATION

Design Line #1: 50kVA Liquid-Immersed, 1-Phase

USER OPTIONS: Reset

Candidate Standard Level	98.90%	Level 1: TP 1
Transformer Load Growth / Year		Med (1%)
Transformer Loading (relative to current estimate)		Med (0%)
Electricity Prices (relative to current estimate)		Med (0%)
Transformer Customer A's & B's		Med
Future Energy Price Trend		AEO 2003 Reference
Cost Minimization Data		U.S. Only
Efficiency Standard Effective Date		2007

LCC RESULT FOR AVERAGE TRANSFORMER:

	Baseline	Candidate Standard Level 1	Difference
No-load Losses @100% load	172.7	140.6	
Load Losses @100% load	447.7	442.9	
First Cost	$1,500	$1,551	$51
Life-Cycle Cost	$4,914	$4,790	-$124
For 50% Evaluators:			
Customer No-load Loss Valuation (A)*	$5.00	$5.00	
Customer Load Loss Valuation (B)*	$1.25	$1.25	
PWF of No-load Loss per W (~A)**	$5.37	$5.37	
PWF of Load Loss per W (~B)**	$1.28	$1.28	
RMS Loading *(% nameplate)*	35.3%	35.3%	
Payback Period *(years)*	n/a	5.8	
Transformer Lifetime *(years)*	32.0	32.0	

* Average A & B values for those customers that evaluate transformer losses during purchase.

** PWF is the Present Worth Factor of losses. The PWF is defined as the present value of loss expenses divided by the rated losses. The PWF has units of $/watt.

Summary Sheet from Spreadsheet

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Load Losses @100% load	447.7	442.9	
First Cost	$1,500	$1,551	$51
Life-Cycle Cost	$4,914	$4,790	-$124
For 50% Evaluators:			

Level 0: Base
Level 1: TP 1
Level 2: TP 1 + 0.2%
Level 3: TP 1 + 0.4%
Level 4: TP 1 + 0.5%
Level 5: TP 1 + 0.68%
Level 6: Custom

sses during purchase.
e present value of loss

Summary Sheet from Spreadsheet

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Candidate Standard Level	98.90%	Level 1: TP 1
Transformer Load Growth / Year		Med (1%)
Transformer Loading (relative to current estimate)		Med (0%)
Electricity Prices (relative to current estimate)		Med (0%)
Transformer Customer A's & B's		Med
Future Energy Price Trend		AEO 2003 Reference
Cost Minimization Data		U.S. Only
Efficiency Standard Effective Date		2007

LCC RESULT FOR AVERAGE TRANSFORMER:

	Baseline	Candidate Standard Level 1	Difference
No-load Losses @100% load	172.7	140.6	
Load Losses @100% load	447.7	442.9	
First Cost	$1,500	$1,551	$51
Life-Cycle Cost	$4,914	$4,790	-$124
For 50% Evaluators:			

Med (1%)
High (2%)
Med (1%)
None (0%)

es during purchase.

** PWF is the Present Worth Factor of losses. The PWF is defined as the present value of loss expenses divided by the rated losses. The PWF has units of $/watt.

TRANSFORMER LIFE-CYCLE COST CALCULATION

Design Line #1: 50kVA Liquid-Immersed, 1-Phase

USER OPTIONS: Reset

Candidate Standard Level	98.90%	Level 1: TP 1
Transformer Load Growth / Year		Med (1%)
Transformer Loading (relative to current estimate)		Med (0%)
Electricity Prices (relative to current estimate)		Med (0%)
Transformer Customer A's & B's		Med
Future Energy Price Trend		AEO 2003 Reference
Cost Minimization Data		U.S. Only
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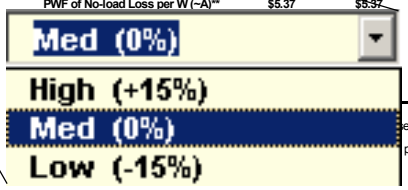
First Cost	$1,500	$1,551	$51
Life-Cycle Cost	$4,914	$4,790	-$124
For 50% Evaluators:			
Customer No-load Loss Valuation (A)*	$5.00	$5.00	
Customer Load Loss Valuation (B)*	$1.25	$1.25	
PWF of No-load Loss per W (~A)**	$5.37	$5.37	



es during purchase.
present value of loss

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Summary Sheet from Spreadsheet

TRANSFORMER LIFE-CYCLE COST CALCULATION

Design Line #1: 50kVA Liquid-Immersed, 1-Phase

USER OPTIONS: Reset

Candidate Standard Level	98.90%	Level 1: TP 1
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Transformer Loading (relative to current estimate)		Med (0%)
Electricity Prices (relative to current estimate)		Med (0%)
Transformer Customer A's & B's		Med
Future Energy Price Trend		AEO 2003 Reference
Cost Minimization Data		U.S. Only
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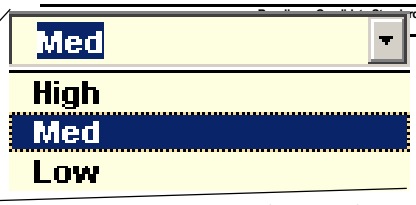
LCC RESULT FOR AVERAGE TRANSFORMER:



			Difference
			$51
			-$124
PWF of No-load Loss per W (~A)**	$5.37	$5.37	
PWF of Load Loss per W (~B)**	$1.28	$1.28	
RMS Loading *(% nameplate)*	35.3%	35.3%	
Payback Period *(years)*	n/a	5.8	
Transformer Lifetime *(years)*	32.0	32.0	

* Average A & B values for those customers that evaluate transformer losses during purchase.

** PWF is the Present Worth Factor of losses. The PWF is defined as the present value of loss expenses divided by the rated losses. The PWF has units of $/watt.

Summary Sheet from Spreadsheet

TRANSFORMER LIFE-CYCLE COST CALCULATION

Design Line #1: 50kVA Liquid-Immersed, 1-Phase

USER OPTIONS: Reset

Candidate Standard Level	98.90%	Level 1: TP 1
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Electricity Prices (relative to current estimate)		Med (0%)
Transformer Customer A's & B's		Med
Future Energy Price Trend		AEO 2003 Reference
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AEO 2003 Reference
AEO 2003 Reference
AEO 2003 High Growth
AEO 2003 Low Growth
Constant Real Price

LCC RESULT FOR AVERAGE TRANSFORMER:

			Difference
Customer Load Loss Valuation (B)	$1.25	$1.25	
PWF of No-load Loss per W (~A)**	$5.37	$5.37	
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RMS Loading *(% nameplate)*	35.3%	35.3%	
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Questions?

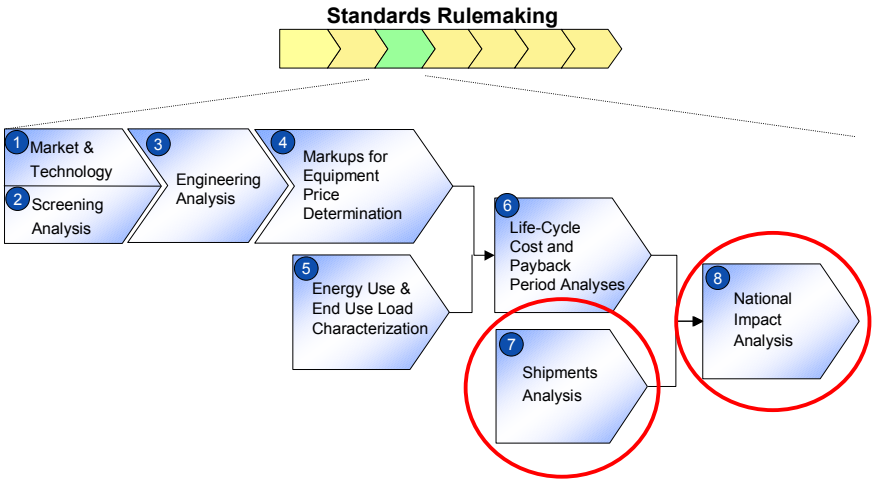
- **U.S. Department of Energy Distribution Transformer Spreadsheet Website**
  - **http://www.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers_spreadsheets.html**
- **Lawrence Berkeley National Laboratory**
  - **John Stoops tel: 510 486 6114, jlstoops@lbl.gov**
  - **Robert Van Buskirk tel: 510 495 2310, rdvanbuskirk@lbl.gov**

Agenda

1. Rulemaking Overview
2. Product Classes
3. Engineering Analysis
4. Life-Cycle Cost and Payback Periods
5. **National Impact Analysis**

Rulemaking Overview

ANOPR Analyses Flow Diagram



The Need for National Impact Analysis

Q. Why isn't the LCC the end of the economic analysis for the nation?

A. Briefly, the LCC is performed from the perspective of transformer customers and is not the sole expression of national impacts.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

The Need for National Impact Analysis

Q. How does national impact analysis differ from LCC?

A. Specifically,

1. **Transformers come in many sizes**
2. **Not all transformers are replaced at once**
3. **The energy consumed at the site is not the energy consumed at the power plant**
4. **National value of future savings may be different from the consumer value of savings**

Purpose

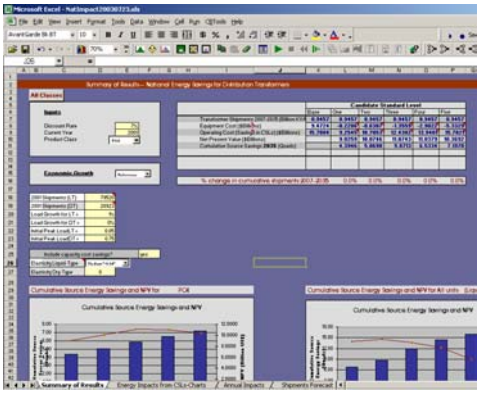
- Estimate national energy savings (NES) (Quads primary)
- Estimate national economic impacts (national NPV)

Method

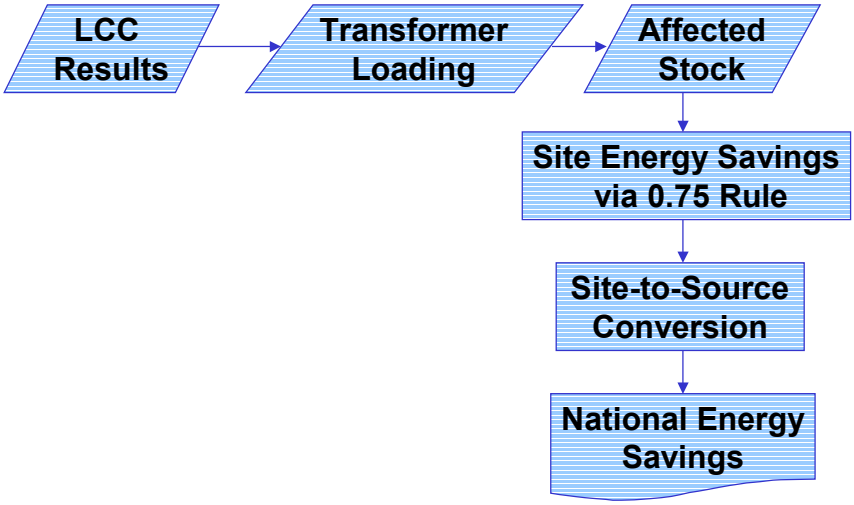
- Spreadsheet-based tool
- Annual time series
- National summations
- Projected to the future
  - Purchases to 2035
  - Energy impact to 2035 (source)
  - Economic impact to 2070

National Impact Analysis (1 spreadsheet)

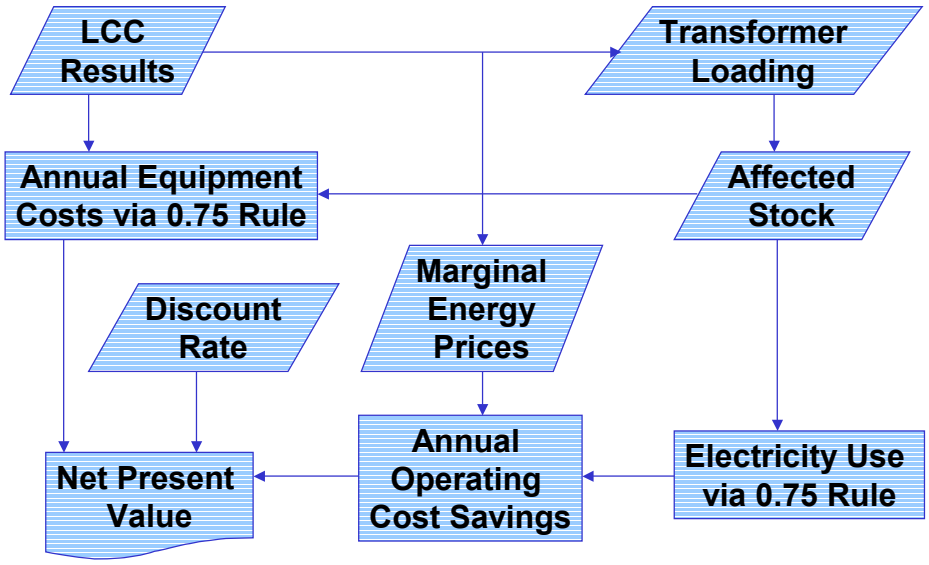
http://www.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers_spreadsheets.html



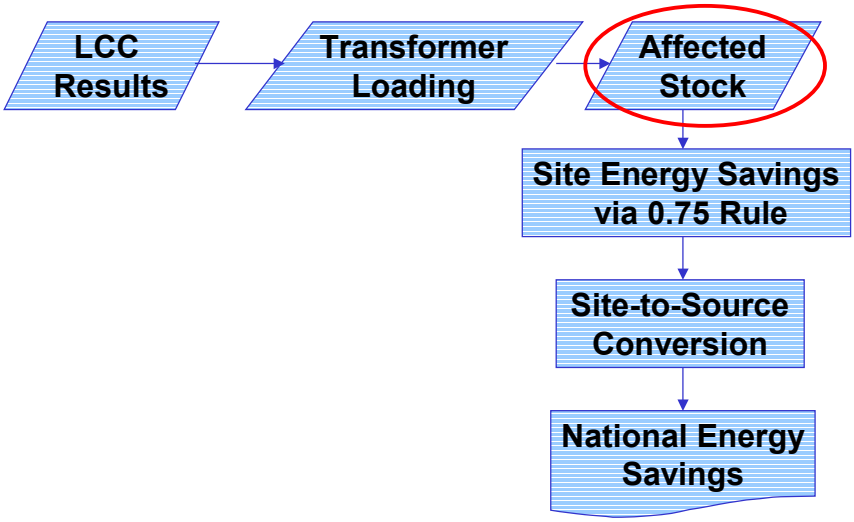
National Energy Savings: Simplified Flowchart



National Net Present Value: Simplified Flowchart



National Energy Savings: Simplified Flowchart

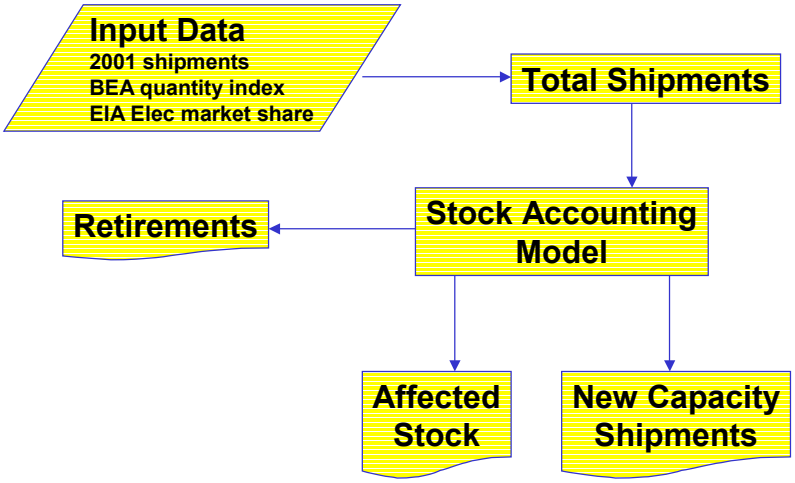


Shipments Model

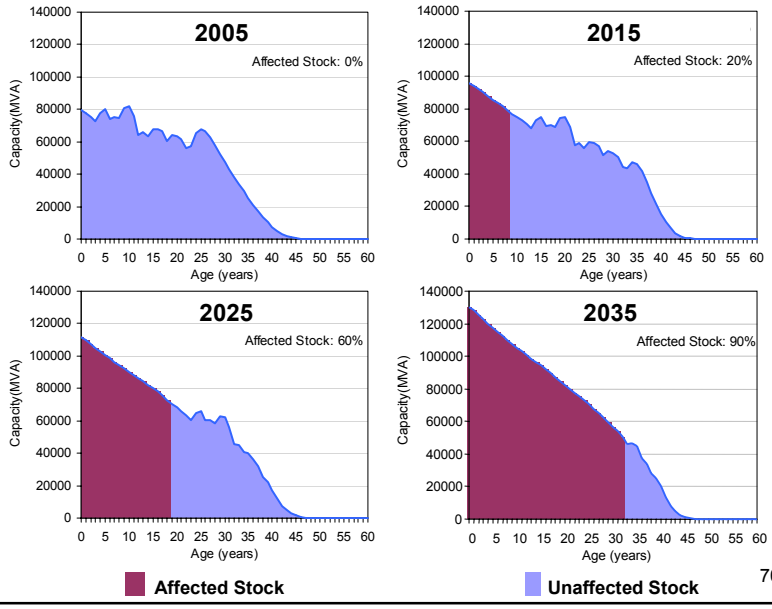
Affected Stock

- The shipments model provides annual age distribution of transformers for past, present, and future years
- Accounting for replacements allows estimate of age distribution of installed transformers

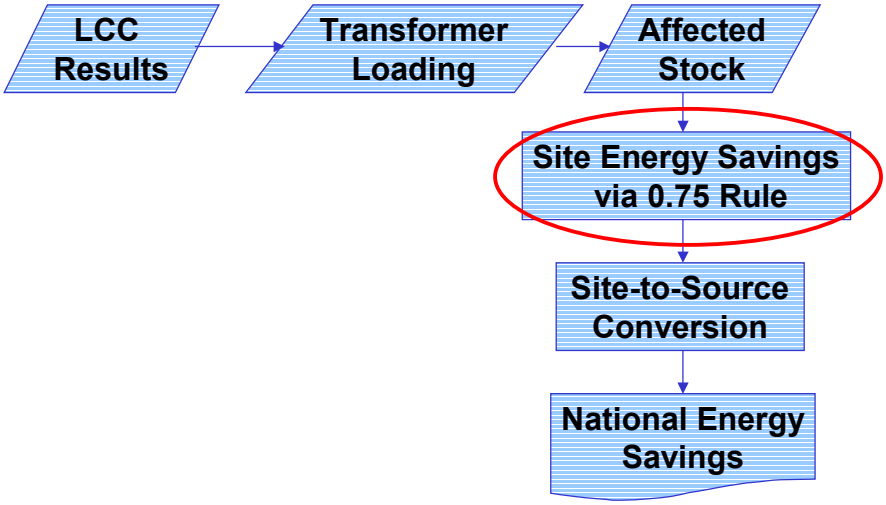
Shipments Model: Simplified Flowchart



Age Distribution of Liquid-Immersed Transformer Stock, Four Selected Years



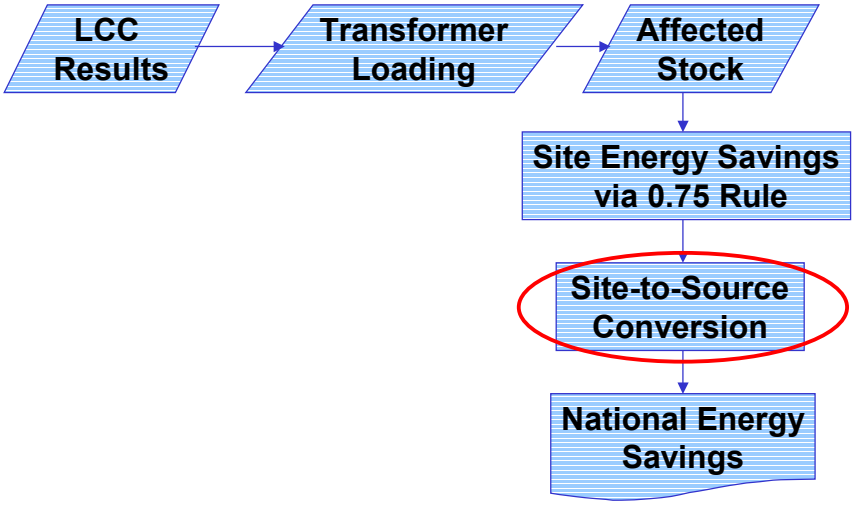
National Energy Savings: Simplified Flowchart



National Impact Analysis

Site Energy Savings via 0.75 Scaling Rule

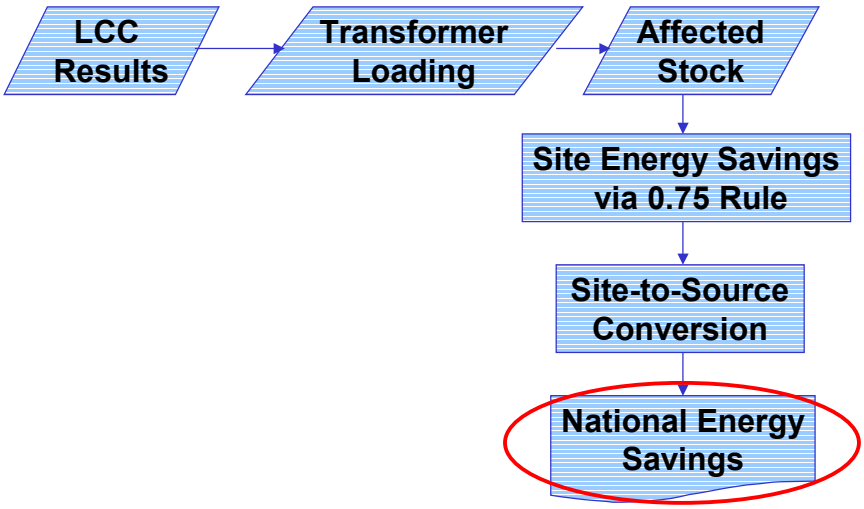
- Grouped 115 different kVA ratings into 13 design lines with representative units (selected high volume ratings)
- Translates findings from the unit analyzed to other kVA ratings within a given engineering design line



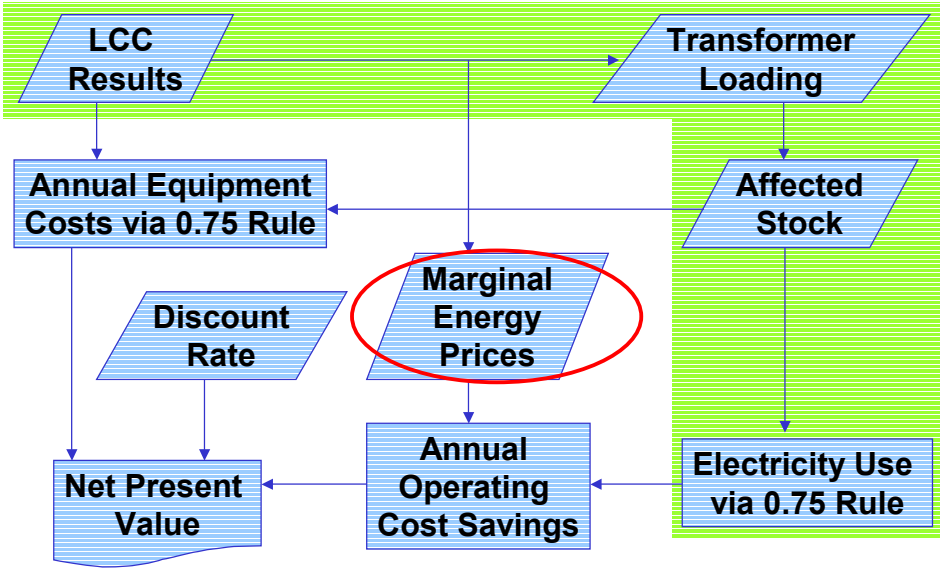
Site-to-Source Conversion

- Energy consumed at the site does not equal energy at the power plant
  - Conversion losses
  - Transmission and distribution losses
  - Generation fuel mix
  - Generation plant mix change over time
- Conversion done with DOE's National Energy Modeling System (NEMS)

National Energy Savings: Simplified Flowchart

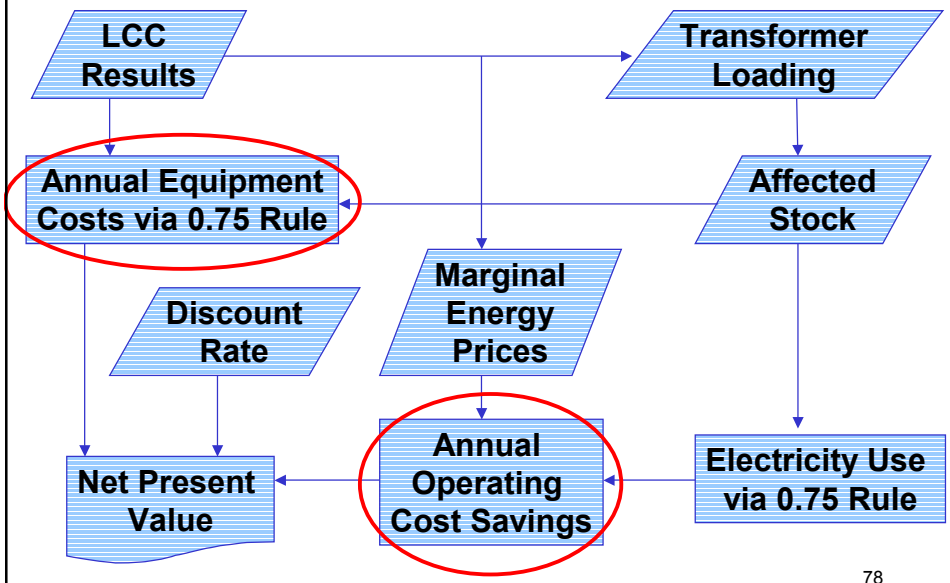


National Net Present Value: Simplified Flowchart



Marginal Energy Prices

- Imported from LCC
- Product class-specific
- Distinct for load loss and no-load loss

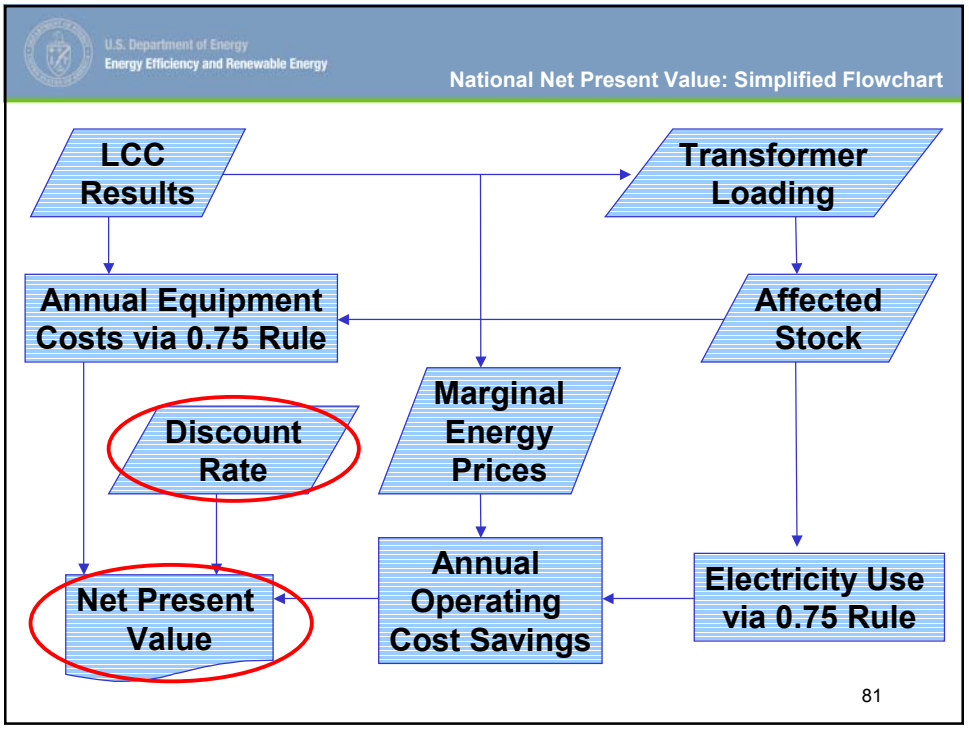


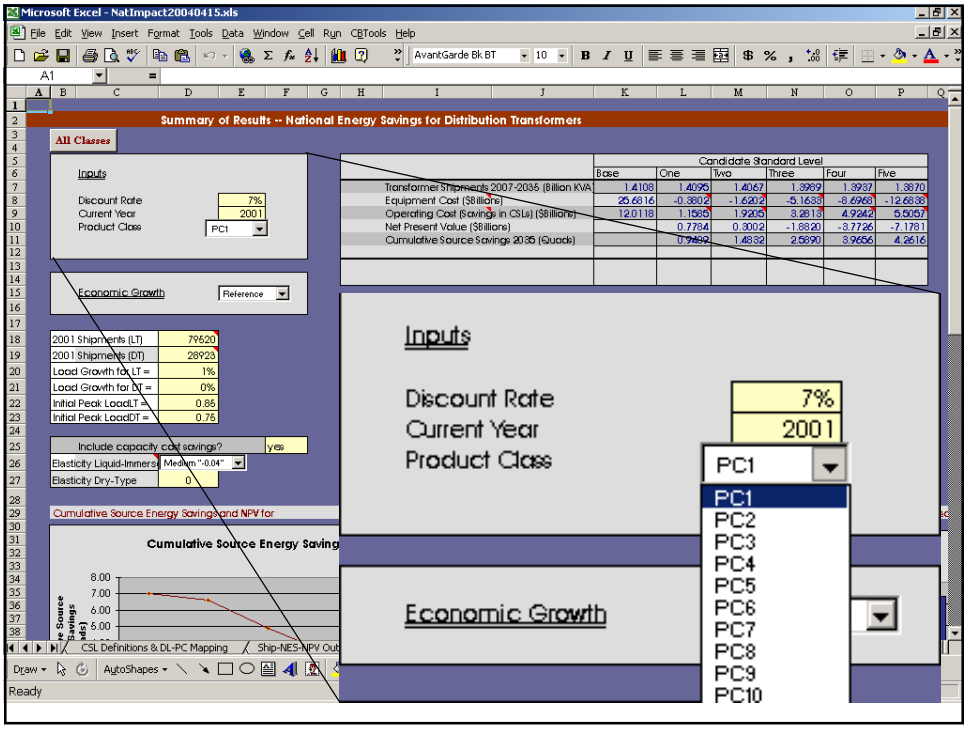
Annual Equipment Costs via 0.75 Rule

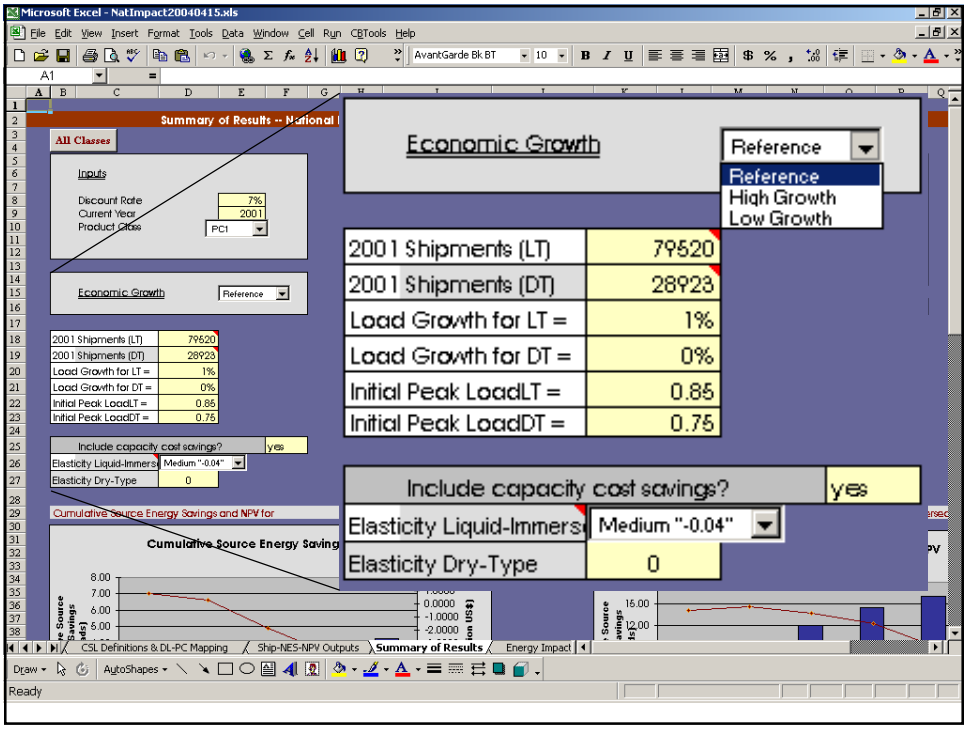
- The scaling of equipment cost to product classes from representative units
- Uses 0.75 power scaling rule

Discount Rate

- National average
- Office of Management and Budget (OMB) mandated 7%
- OMB Mandated 3%


U.S. Department of Energy
Energy Efficiency and Renewable Energy
National Net Present Value: Simplified Flowchart
LCC Results
Transformer Loading
Annual Equipment Costs via 0.75 Rule
Affected Stock
Discount Rate
Marginal Energy Prices
Net Present Value
Annual Operating Cost Savings
Electricity Use via 0.75 Rule
81


Microsoft Excel - NatImpact20040415.xls
Summary of Results -- National Energy Savings for Distribution Transformers
All Classes
Inputs
Discount Rate 7%
Current Year 2001
Product Class PC1
Economic Growth Reference
Candidate Standard Level
Base One Two Three Four Five
Transformer Shipments 2007-2035 (Billion KVA) 1.4108 1.4095 1.4067 1.3989 1.3937 1.3870
Equipment Cost ($Billions) 25.6816 -0.3802 -1.6202 -5.1633 -8.6968 -12.6838
Operating Cost (Savings in CSLs) ($Billions) 12.0118 1.1585 1.9205 3.2813 4.9242 6.5057
Net Present Value ($Billions) 0.7784 0.3002 -1.8820 -3.7726 -7.1781
Cumulative Source Savings 2035 (Quads) 0.9489 1.4832 2.5890 3.9656 4.2616
2001 Shipments (LT) 79520
2001 Shipments (DT) 28923
Load Growth for LT = 1%
Load Growth for DT = 0%
Initial Peak LoadLT = 0.85
Initial Peak LoadDT = 0.75
Include capacity cost savings? yes
Elasticity Liquid-Immersed Medium "-0.04"
Elasticity Dry-Type 0
Cumulative Source Energy Savings and NPV for
Cumulative Source Energy Saving
8.00
7.00
6.00
5.00
CSL Definitions & DL-PC Mapping
Ship-NES-NPV Out
Inputs
Discount Rate 7%
Current Year 2001
Product Class PC1
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PC8
PC9
PC10
Economic Growth
Draw
AutoShapes
Ready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High Growth
Low Growth
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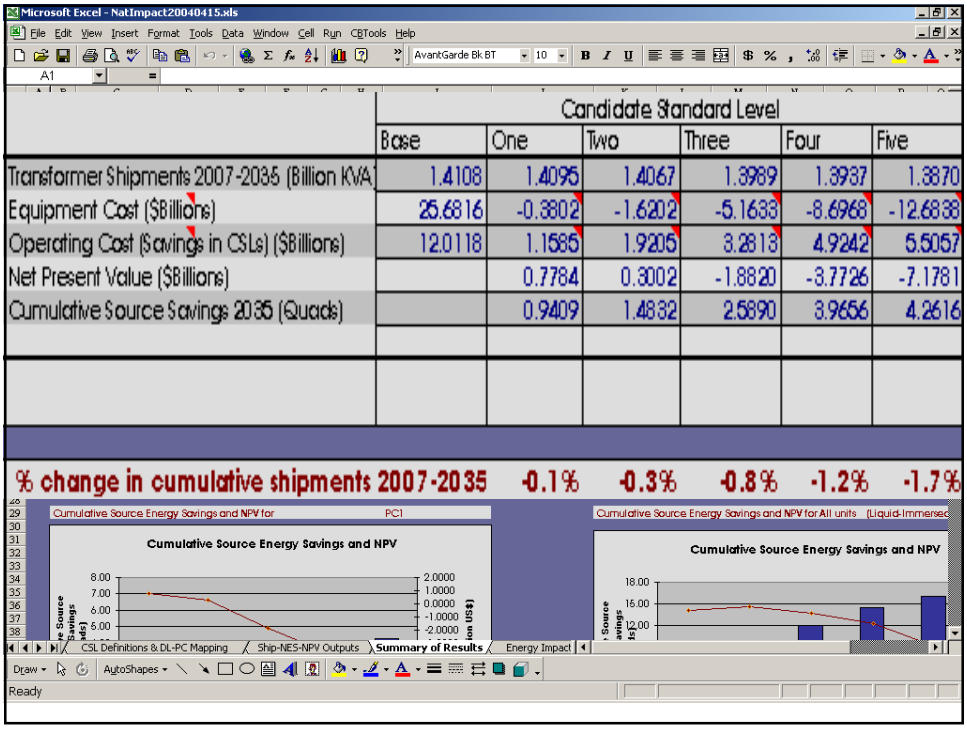
Cumulative Source Energy Saving
CSL Definitions & DL-PC Mapping
Ship-NES-NPV Outputs
Summary of Results
Energy Impact
Ready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Candidate Standard Level
Base
One
Two
Three
Four
Five
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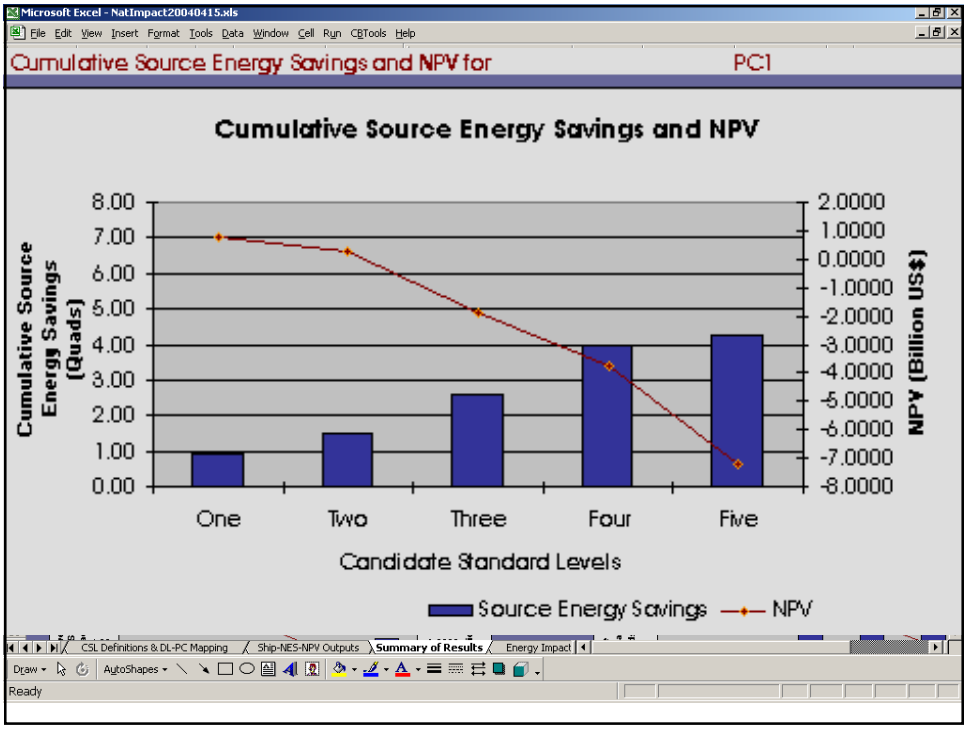
% change in cumulative shipments 2007-2035 -0.1% -0.3% -0.8% -1.2% -1.7%
Cumulative Source Energy Savings and NPV for PC1
Cumulative Source Energy Savings and NPV
Cumulative Source Energy Savings and NPV for All units (Liquid-Immersed
Cumulative Source Energy Savings and NPV
CSL Definitions & DL-PC Mapping
Ship-NES-NPV Outputs
Summary of Results
Energy Impact
Ready


Microsoft Excel - NatImpact20040415.xls
File Edit View Insert Format Tools Data Window Cell Run CBTools Help
Cumulative Source Energy Savings and NPV for PC1
Cumulative Source Energy Savings and NPV
Cumulative Source Energy Savings (Quads)
NPV (Billion US$)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
2.0000
1.0000
0.0000
-1.0000
-2.0000
-3.0000
-4.0000
-5.0000
-6.0000
-7.0000
-8.0000
One
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Summary of Results
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Draw
AutoShapes
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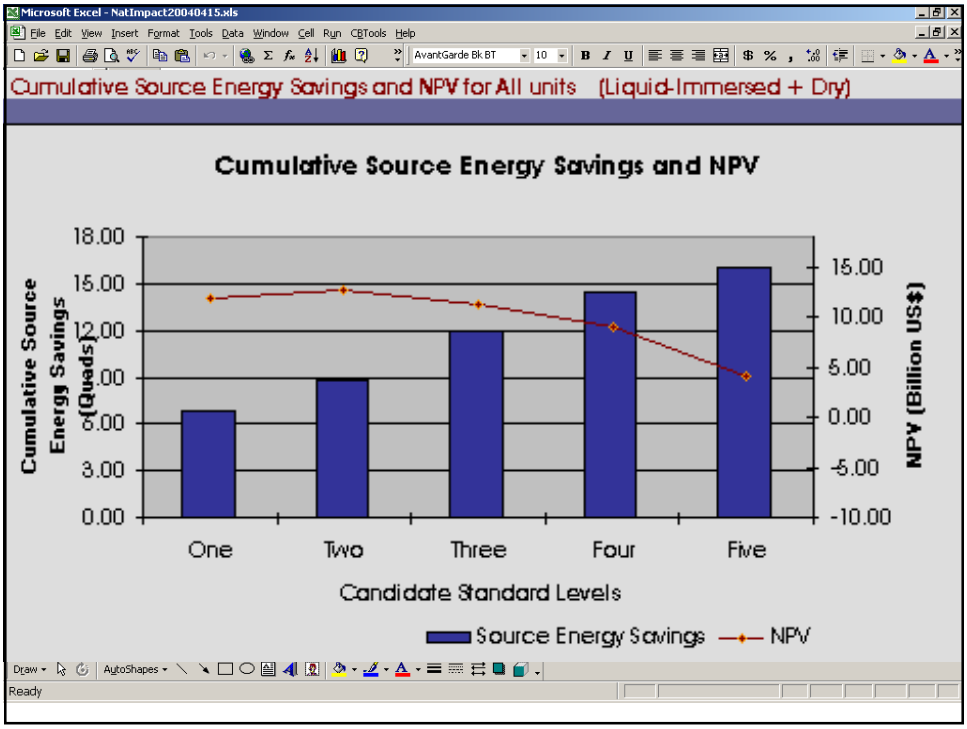
Microsoft Excel - NatImpact20040415.xls
File Edit View Insert Format Tools Data Window Cell Run CBTools Help
AvantGarde Bk BT
10
Cumulative Source Energy Savings and NPV for All units (Liquid-Immersed + Dry)
Cumulative Source Energy Savings and NPV
Cumulative Source Energy Savings (Quads)
NPV (Billion US$)
18.00
15.00
12.00
9.00
6.00
3.00
0.00
15.00
10.00
5.00
0.00
-5.00
-10.00
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Three
Four
Five
Candidate Standard Levels
Source Energy Savings
NPV
Draw
AutoShapes
Ready

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Thank you and for more information…

- U.S. Department of Energy Appliance Rulemaking Website
  - http://www.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers_anopr.html
- U.S. Department of Energy
  - Ron Lewis tel: 202 586 8423, Ronald.Lewis@ee.doe.gov
- Navigant Consulting
  - Mike Scholand tel: 202 973 2482, Mscholand@navigantconsulting.com
- Lawrence Berkeley National Laboratory
  - John Stoops tel: 510 486 6114, jlstoops@lbl.gov
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